

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of

Applicants : Kurt Friedrich Brandstadt et al.  
Serial No. : 10/791,951  
Filed : March 03, 2004  
Title : **METHODS FOR FORMING STRUCTURALLY DEFINED ORGANIC MOLECULES**  
Docket No. : DOG 0084 PA / 35319.50  
Examiner : R. Prouty  
Art Unit : 1652  
Confirmation No. : 1997

**MAIL STOP RCE**  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

Dear Sir:

**DECLARATION UNDER 37 C.F.R. 1.132**

Kurt F. Brandstadt, Thomas H. Lane, John C. Saam, and Joseph C. McAuliffe each declare that:

1. We are co-inventors of and are familiar with the present application Serial No. 10/791,951.
2. In support of our application, we are submitting the additional information contained in the pages attached to our declaration. This additional information is taken from Examples 14-16 in our commonly-assigned PCT International Patent Application No. WO 2005/085459, which claims priority from this U.S. application Serial No. 10/791,951. The additional Examples demonstrate the ability of cutinase to catalyze the condensation of trimethylsilanol (Ex. 14), the ability of cutinase to catalyze the hydrolysis and condensation of dimethyldimethoxysilane (Ex. 15), and the ability of trypsin to catalyze the hydrolysis and condensation of diethyldiethoxygermane (Ex. 16). The processes described in these examples follows the teachings in our Serial No. 10/791,951.

3. We further declare that all statements made herein of our own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Kurt F. Brandstadt  
Kurt F. Brandstadt

10/12/07  
Date

Thomas H. Lane  
Thomas H. Lane

10/12/07  
Date

John C. Saam  
John C. Saam

10/15/07  
Date

Joseph C. McAuliffe

Date

3. We further declare that all statements made herein of our own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Kurt F. Brandstadt

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Date

Thomas H. Lane

Date

John C. Saam

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Date

Joseph C. McAuliffe

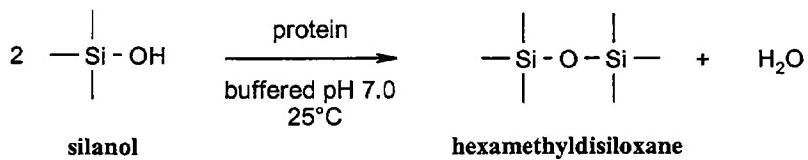
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Date

### Cutinase-catalyzed condensation of trimethylsilanol

A model study was performed in which a mono-functional silane was chosen to focus on the formation of molecules with a single siloxane bond during the *in vitro* condensation of trimethylsilanol (Scheme 6). The biocatalyzed reactions were formulated with a 5:1 trimethylsilanol to protein weight ratio (i.e. ~1,300:1 trimethylsilanol to cutinase mole ratio, 0.3  $\mu$ mol cutinase) in 50 mM Tris-HCl buffered Milli-Q water (pH 7.0) at an ~10:1 solvent to monomer weight ratio. The closed (screw capped) two-phase reactions were conducted in inert glass vials at 25°C with magnetic stirring for 14 hours. Specifically, the reactions were conducted in silylated glassware. Since a silanol-functional glass surface could react with trimethylsilanol, the silylated glassware was necessary to create an inert glass surface. Prior to analysis, the aqueous reactions were extracted with THF in the presence of NaCl and filtered through a Whatman Autovial® 5 0.45  $\mu$ m Teflon® filter. The reaction products were quantitatively analyzed by gas chromatography-flame ionization detection (GC-FID).

In this study, control reactions were defined as non-enzymatic reactions. Experiments conducted in the absence of a protein were defined as negative control reactions. Proteinaceous molecules such as bovine serum albumin (BSA) and porcine- $\gamma$ -globulins (globulins) were used to study non-specific protein catalysis. Substantial condensation of trimethylsilanol was not observed in the negative control and non-specific protein reactions in comparison to the raw material (trimethylsilanol, Me<sub>3</sub>SiOH). In review, cutinase catalyzed the condensation of trimethylsilanol during the formation of hexamethyldisiloxane (HMDS) under mild conditions. Although the condensation reaction was conducted in water, the enzyme-catalyzed reaction was promoted by the phase separation of the product. The immiscibility of the product, hexamethyldisiloxane, changed the equilibrium and promoted the condensation reaction in the presence of water. Since the aqueous medium was saturated with trimethylsilanol (i.e. a two-phase reaction mixture), the reactant would continue to enter the aqueous phase due to the dynamic equilibrium of the condensation reaction.



**Scheme 6:** Biocatalyzed condensation of trimethylsilanol.

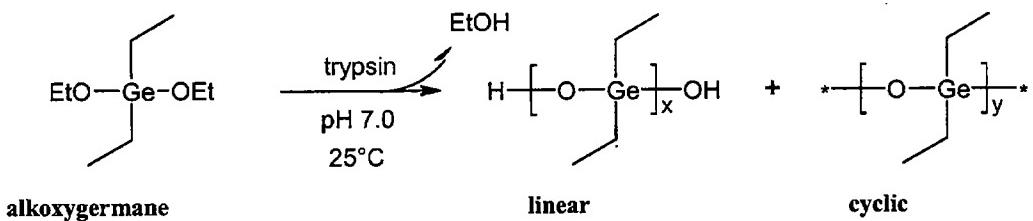
### Cutinase-Catalyzed Hydrolysis and Condensation of Dimethyldimethoxysilane

Dimethyldimethoxysilane (DMDM) was chosen as a model substrate to investigate the ability of cutinase to catalyze the *in vitro* hydrolysis and condensation of a multi-functional alkoxy silane under mild conditions (Scheme 7). The mild reaction conditions (i.e. low temperature, neutral pH) minimize chemically catalyzed condensation due to the increased concentration of silanol in the reaction mixture. The biocatalyzed reactions were initially formulated with an ~10:1 alkoxy silane to cutinase weight ratio (i.e. ~1,800:1 DMDM to cutinase mole ratio, ~5  $\mu$ mol cutinase) in 50 mM Tris-HCl buffered Milli-Q water (pH 7.0) at an ~60% volumetric efficiency. Volumetric efficiency was defined as the weight % monomer measured as a percentage of the total weight of the liquids in the reaction (i.e. DMDM + water). The closed (screw capped) two-phase reactions were conducted in inert glass vials at 25°C with magnetic stirring for 24 hours. Specifically, the reactions were conducted in silylated glassware. Since a silanol-functional glass surface could react with the alkoxy silane in the study, the silylated glassware was necessary to create an inert glass surface. Prior to analysis, the aqueous reactions were extracted with THF in the presence of NaCl and filtered through a Whatman Autovial® 5 0.45  $\mu$ m Teflon® filter. The reaction products were analyzed by GC-FID in a qualitative manner (i.e. area percent, Table 6).

In review (Table 6), the degree of polycondensation catalyzed by ~5  $\mu$ mol of cutinase was not significantly greater than the negative control reaction conducted in the absence of cutinase over a 24-hour period. Consequently, the cutinase-catalyzed polycondensation reactions were replicated with an increased amount of enzyme (i.e. ~500:1 DMDM to cutinase mole ratio, ~20  $\mu$ mol cutinase) over a longer period of time (5 days). Based on the degree of polycondensation obtained over an extended period of time (5 days vs. 24 hours) at two concentrations of enzyme (20  $\mu$ mol vs. 5  $\mu$ mol), cutinase was observed to catalyze the hydrolysis and condensation of DMDM (Table 7). Although the condensation reactions were conducted in water, the enzyme-catalyzed reactions were promoted by the phase separation of the products. Based on the estimated solubility of DMDM in water (~32 mg/mL), the concentration of DMDM (~1500 mg/mL) saturated the aqueous medium and created a two-phase reaction mixture. As the chain length of the linear siloxane molecules increase or cyclic siloxanes are formed, these molecules phase separate into the organic phase.

### Trypsin-Catalyzed Hydrolysis and Condensation of Diethyldiethoxygermane

Diethyldiethoxygermane was chosen as an alternate substrate in order to investigate the ability of bovine pancreatic trypsin to catalyze the *in vitro* hydrolysis and condensation of an alkoxy-functional germanium molecule under mild conditions (Scheme 8). The mild reaction conditions (i.e. low temperature, neutral pH) minimize chemically catalyzed condensation due to the increased concentration of hydroxy groups in the reaction mixture. The reactions were formulated with an ~5:1 monomer to enzyme weight ratio (i.e. ~500:1 diethyldiethoxygermane to trypsin mole ratio, ~1  $\mu\text{mol}$  trypsin) in 50 mM Tris-HCl buffered Milli-Q water (pH 7.0) at an ~5:1 solvent to monomer weight ratio. The closed (screw capped) two-phase reactions were conducted in inert glass vials at 25°C with magnetic stirring for 24 hours. Specifically, the reactions were conducted in silylated glassware. Since a silanol-functional glass surface could react with the monomer, the silylated glassware was necessary to create an inert glass surface. Prior to analysis, the aqueous reactions were extracted with THF in the presence of NaCl and filtered through a Whatman Autovial® 5 0.45  $\mu\text{m}$  Teflon® filter. The reaction products were analyzed by gas chromatography-mass spectrometry (GC-MS) and electrospray ionization mass spectrometry (ESI MS). In comparison to a negative control reaction conducted in the absence of the enzyme, trypsin was observed to catalyze the hydrolysis and condensation of diethyldiethoxygermane during the preferential formation of hexaethylcyclotrigeroxane,  $[\text{Et}_2\text{GeO}]_3$  where Et =  $\text{CH}_2\text{CH}_3$ .



**Scheme 8:** Trypsin-catalyzed hydrolysis and condensation of diethyldiethoxygermane